

coincidentally correspond to the curvature * * * [of cyclone paths referred to previously.] * * * I had nine years study of it [in looking over the logs of eastward-bound vessels].

These "dumb-bell winters" are very provoking to the agriculturist on account of the mock spring they cause. People sow accordingly, and just about the time the plants are above the ground (late September or the first week of October) about eight weeks or two months wintry weather sets in, causing no end of trouble. Our politicians gape aghast when they see the cost of observing and recording "effects" (the money expended in trying to get at the cause or causes is infinitesimal) and as a consequence they have the Meteorological Department "set" as "useless," "farfical," "waste of money," etc.

Every year the wind vane at Cape Leeuwin lighthouse tells the Australian world its part of the story with the greatest reliability, but year after year it passes unheeded, not understood, etc. We here, on this bit of land, 40 by 16 [miles], take no interest in statistics of the past. However, is nothing deducible from those statistics? If not, where does the value come in?

What is needed in Australia is a solar observatory, and some of the thousands of pounds sterling that are spent annually in the compilation of data could be devoted with far greater benefit to the Australian people to such an observatory, for it is mainly by the existence or otherwise of the curvature I refer to that so many millions of Australian money are affected.

It seems absurd to think that the Government meteorologist in Melbourne can not inform the people early in June of such curvature when the masters of vessels tell him that their vessel emerged from a dense wall or mountain of coarse weather near St. Pauls and steamed for 8 to 10 days through an easterly gale in comparatively clear weather—what is that but the plainest evidence of the curvature of the usual belt northward—for the same masters visit King Island and they will find the same or similar conditions recorded? * * * In years to come perhaps some one will succeed in getting at the cause of the variation [icebergs, solar variations?] and thus render a great service to thousands of helpless beings who are from time to time ruined by the effects of drought and broken winters too.—C. Richardson.

THE MARINE OBSERVER'S HANDBOOK.¹

(Abstract.)

The second edition of The Marine Observer's Handbook, the standard work on marine meteorology, follows closely the lines of the first edition, issued in 1915. There is a foreword by Sir Napier Shaw, until recently director of the meteorological office, and a brief history of the office. Part I of the handbook is devoted to a description of the instruments and methods of observation required for keeping the meteorological record, or log. Part II deals with observations of wind, sea disturbance, clouds, weather and optical phenomena, including a comprehensive treatment of the subject of waves and swell. Part III comprises instructions for keeping the meteorological records. In the appendix are illustrations of cloud forms, with a graphic guide to their recognition, meteorological tables, instructions for transmitting weather reports from ships at sea by radio telegraphy, and

a list of publications, for the most part issued by the Meteorological Committee and its predecessors.—F. G. Tingley.

DEFINITIONS OF "MEAN," "AVERAGE," AND "NORMAL."

(Dictionary definitions and contributions from C. F. Marvin, A. J. Henry, H. C. Frankenfield, C. F. Talman, J. Warren Smith, P. C. Day, and Cl. Abbe, jr.)

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Dictionaries make little or no distinction between the meanings of the three terms *mean*, *average*, and *normal*; yet in meteorological usage, *normal* has a meaning fairly distinct from *mean* or *average*. Let us consider prevailing definitions of each term; and attempt to arrive at some generalities which should govern the use of each in meteorological statistics.

MEAN.

In Webster's Dictionary¹ we find: "*Mean*. a. 4. *Math.* Average; having an intermediate value between two extremes, or between the several successive values of a variable quantity during one cycle of variation, such that were they all equal, the mean would be their common value. * * * [As a noun]. Usually, unless otherwise specified, it is the one simple average (called arithmetical mean) formed by adding the quantities together in any order and dividing by their number." A more detailed discussion is to be found in the Century Dictionary and Cyclopedia (New York, 1911).

AVERAGE.

From Webster's Dictionary we have the following definition: "*Average*. n. 5. A mean proportion, medial sum, or quantity, made out of unequal sums or quantities; an arithmetical mean." Murray's Dictionary² says that an *average* is the distribution of the aggregate inequalities of a series of things among all members of the series, so as to equalize them and ascertain their common, or mean, quantity, etc., when so treated; the determination or statement of an arithmetical mean; a medial estimate. The Century Dictionary gives: "*Average* II a. 1. Equal in amount to the sum of all the particular quantities of the same sort divided by the number of them; as the average yield of wheat to the acre; the average price of anything for a year; hence 2. of medium character, quality, etc.; midway between extremes; ordinary."

AVERAGE AS DISTINGUISHED FROM MEAN.

Marriott in "Hints to Meteorological Observers" (6th ed., 1906) says that the arithmetical average or mean is the sum of all values forming the series of figures under consideration, divided by their number; and that *average* is the term used for results extending over a long period, while *mean* is used for short periods, e. g., a day, month, or year. Thus we might speak of the *mean* temperature of December, 1918, but of the *average* December temperature during the period, 1899–1918.

Dr. H. R. Mill, director of the British Rainfall organization, says (M. W. R., January, 1915, 43:42): "For convenience I use the term *mean* as indicating the sum of any

¹ 2d ed., Meteorological Office, London, 1918, 142 pp., 28 figs., 7 plates. Price 3s. 6d., net.

² Webster's New International Dictionary, Springfield, Mass., 1911.

³ Sir James A. H. Murray, A New English Dictionary on Historical Principles, etc. Oxford, 1908.

number of figures divided by that number, reserving the word *average* for the mean of a number of figures representing values in order of time. Thus the mean of 30 annual rainfall values is spoken of as the average rainfall for 30 years. The mean of a number of uniformly distributed figures, representing the distribution of rainfall in space I speak of as the general rainfall of the area concerned; thus the mean depth of rainfall over England for any day, month, or year is the *general rainfall* of England for that particular day, month, or year. The mean of the general rainfall of England for 30 years is expressed as the *average general rainfall* of England for 30 years."

The Weather Bureau believes the usage of *general* and *general average* as defined by Dr. Mill is desirable; but prefers not to prescribe nor limit the use of these terms, in view of the varied nature of the publications of the Bureau and the personal customs of authors.

Mathematically, the quantities to which the terms *mean*, *average*, and *normal* are applied in dealing with statistical data are essentially the same, namely the quotient found by dividing the sum of a series of values by the number of values. In ordinary usage there is no essential difference in the significance of *average* and *mean*. In general, it is not of much consequence whether *mean* or *average* is used since the context will usually show what is meant. It is evident, however, that both here and in Great Britain, meteorologists use *mean* in discussing current data, and *average* in discussing the data of a number of years, especially in dealing with areas.

NORMAL.

In Webster's Dictionary we find: "*Normal*. 2. The ordinary or usual condition, degree, quantity, or the like; average; mean." Murray's Dictionary gives: "*Normal*. 3. Physics. The average or mean value of observed quantities. 4. The usual state or condition." The Century Dictionary says: "*Normal* I a. 1. According to a rule, principle, or norm; conforming to established law, order, habit, or usage; conforming with a certain type or standard; not abnormal; regular; natural."

Regarding the question of *normals* in Weather Bureau records, an inquiring correspondent was answered in part as follows: "*Normals* are the averages of all observations available from the beginning of the record at the respective stations to the time the values were completed and put in operation. * * * As a rule normals are not prepared for stations having a record of less than 10 years." (M. W. R., March, 1907, 35: 125.) Thus, the word *normal* is used rather too broadly to represent averages of a period of 20 years and even less. Strictly speaking, "our idea of a normal implies, first, that it is the average of a great number, and second, that it contains within itself nothing abnormal—that is to say, that abnormal events have so counteracted each other as not to injuriously affect the average of many values." (Cleveland Abbe, M. W. R., 1895, 23: 294.)

Prof. C. F. Marvin gives another statement of the meaning of *normal* in meteorology and how it may be obtained:

"While the word *normal* must properly be considered to signify the mean or arithmetical average of a very large number of homogeneous observations, it must nevertheless be recognized that an acceptable value of a normal may be deduced from a shorter series of homogeneous observations by a proper mathematical process. Such a process aims to secure values toward which the observed conditions, as expressed by the average thereof,

tend continually to approach as the record becomes longer and longer.

"It may be quite possible, by properly analyzing the records of temperatures of all, or many, stations of the United States, for example, to formulate an equation showing the normal annual or diurnal march of temperature as a mathematical function of a given form. We are greatly assisted in such an effort if perchance we may know of a rational equation expressing the relations between the element in question and the lapse of time. In meteorology this is unfortunately rarely the case, and too often it is necessary to adopt such purely empirical equations as, for example, the well-known Fourier series. The values obtained by such an analysis give us, possibly, hourly, daily, monthly, seasonal, annual, and other values that may be truly characterized as normals and toward which it is believed the average of a long series of observations will more and more closely approach as the length of record increases. Clearly, however, such normals might differ quite considerably from the averages of 20, 30, 50, or 100 years of records.

"I am doubtful if it would be advisable to specify any number of years of data that would be assumed to be sufficient to justify the use of the word *normal*, but rather leave this a somewhat indefinite interval. Notwithstanding its vagueness of definition the word *normal* is a convenient one to distinguish the average of a few results from the mean of a considerable number, or even of the greatest number of values available."

A meteorological or climatic normal is, at best, a makeshift, because the conception of a normal in its most exact sense implies a stability of climate which may not exist. It is inconsistent with the idea of long-period fluctuations of climate that have occurred—certainly in the course of ages, and probably within historic times. The length of record necessary for practical purposes in any case varies greatly with the location of the station, the element considered, and the interval (day, month, year, etc.).

AVERAGE AND NORMAL.

Average and *normal* appear closely associated, and it is thought they refer generally to the same subject save that *average* might be used when there is more or less uncertainty as to whether the number of terms is sufficient to give a result that would not be appreciably changed by the addition of another, within the probable range of the element. An additional word, very generally necessary, will give the key to the interpretation to be placed upon the term and this very generally appears when they are used.

The fact that so-called normals are more or less close approximations to ideal values is shown by the fact that we often speak of "good normals," "poor normals," "provisional normals," etc. While meteorologists are not misled by the conventional use of this term, it is likely to mislead others. We can not discontinue, however, the use of the word *normal* in our climatological publications, even though, as is obvious, we have few records continued long enough to establish true normals. The "departures from normal," which are really departures from quasi-normals, have nevertheless a very practical value.

We conclude, therefore, that while normals are also means and averages, we should not loosely substitute either of these last two words for *normal* or the reverse any more than we would speak of a *dog* as a *horse* because it was hitched to a cart.